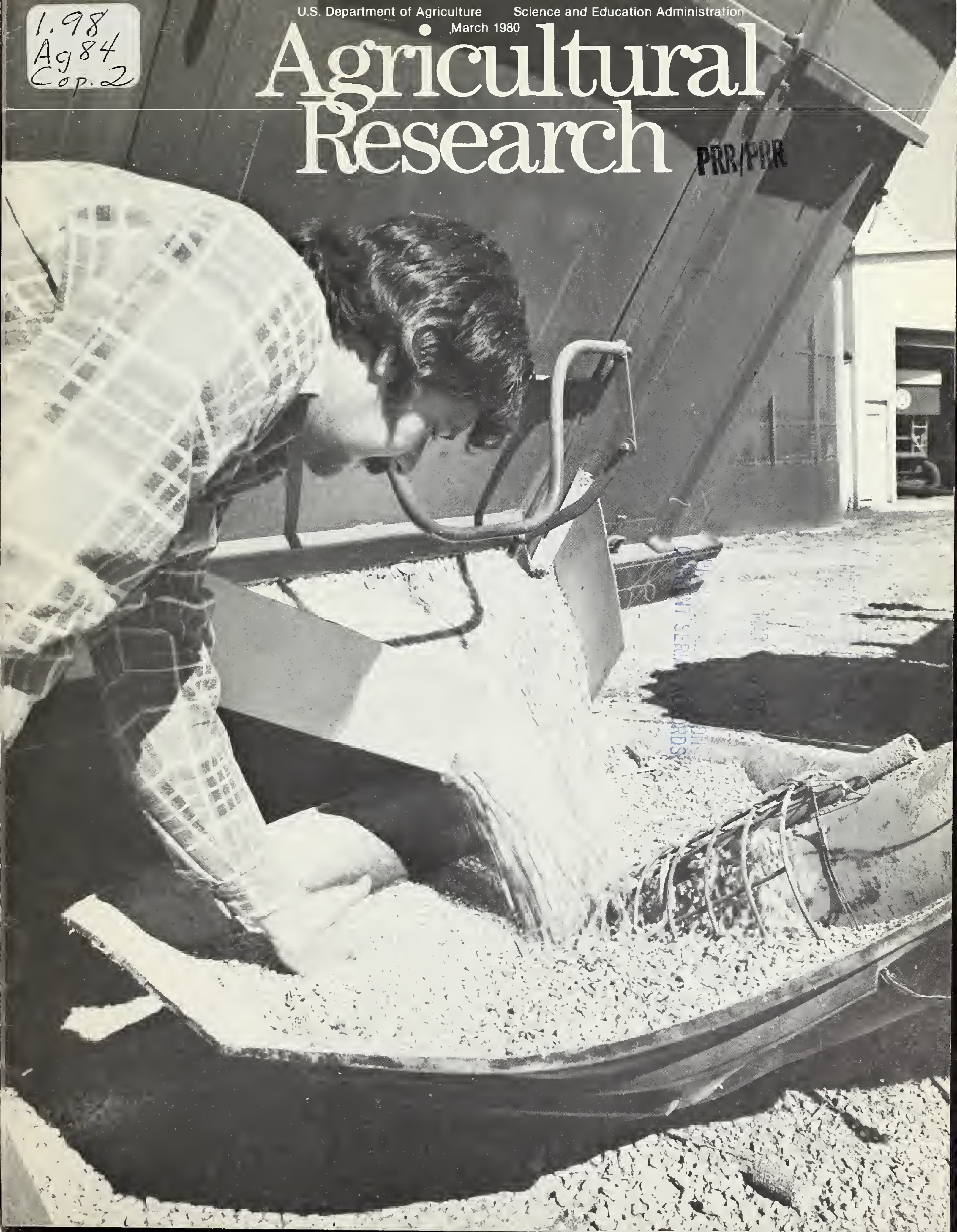
U.S. Department of Agriculture Science and Education Administration
March 1980

Agricultural Research



A Hungry, Quarreling, Uneasy World—The Challenge to Agricultural Research in the 1980's*

Dr. Anson R. Bertrand
Director of Science and Education

Many of us are convinced that one of our greatest needs is for fundamental research to find new principles and new methods that will help us understand basic biological processes.

The pool of fundamental knowledge sets the base and limits of applied and developmental research, which in turn can be translated into technologies for application and use. Many costly and inefficient applied efforts can be avoided if sufficient effort is devoted to generating new knowledge through basic research.

The plain fact is that we do not know enough today to significantly increase the efficiency of our food production. With the year 2000 only a short 20 years away, we do know that without accelerated research efforts and some major breakthroughs, the rate of growth of our food crops will not keep pace with needs . . . will not keep pace with what our hungry, quarreling, uneasy world will demand from us.

If we can better understand and control the mechanisms and functions of living cells, we will have vastly increased our ability to breed more productive, higher quality crops and livestock . . . to control diseases and pests . . . to maintain the quality of farm products during processing and marketing . . . to find new uses for our farmgrown raw materials . . . to preserve and enhance our environment . . . to collect and use wisely the energy resources available to us . . . and to improve the nutritional well-being of our people. This will be no small accomplishment. It will be no small task—this challenge to Agricultural Research in the 1980's.

*Parts excerpted from remarks by Dr. Bertrand commemorating the 100th anniversary of the Indiana Agricultural Experiment Station, November 1979

Fundamental research in the agricultural sciences has received cyclic attention over the past 25 to 30 years. This country has come to expect near miracles from our unique agricultural system.

The future of our food supply and our ability to meet the ever-growing demands of foreign markets depends upon the current perceptions of public opinion leaders, policymakers, and planners as to the wisdom of investment in the food and agricultural sciences.

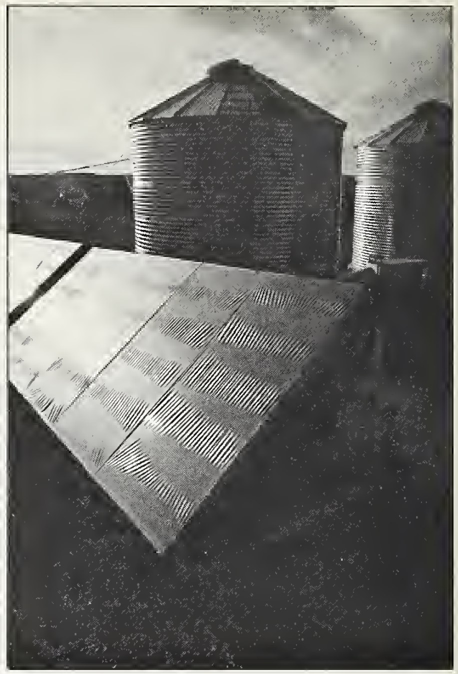
The January 4th decision of the President to suspend U.S. agricultural exports and shipments of grain to the Soviet Union is but one example of how rapidly changes come upon us.

It has become abundantly clear that the food and agriculture industry of the United States, including the research and education component, faces challenges which will tax its resources and imagination to the utmost. It is largely because of research done 10, 20, 30 years ago that we have the abundance of grain we do today. We would have to conclude that those investments in agricultural research that were made in the 1940's, 50's and 60's have paid off.

Not only was our agricultural system able to provide the President with this option, but now, when grain storage is needed, we are in the fortunate position of having ample storage space for current supplies. USDA's estimate on October 1, 1979 showed room for about 2 billion bushels of grain.

We are also ready with storage technology as a result of on-going research. This issue of Agricultural Research reports on three grain storage research projects: solar grain drying, grain dust, and controlling grain insects through the use of Bacillus thuringiensis.

They are excellent examples of how our scientists, engineers, and research administrators have drawn on basic studies and responsibly related our goals, policies, and programs to national needs and priorities.



We must continue to evaluate our efforts in line with the Nation's needs and use the contributions we are making as evidence of the benefits that derive from a soundly supported agricultural research and education system.

As agricultural scientists and educators, we are equal to the tasks before us. Our research-extension-teaching partnership has built within it a spirit that encourages the sharing of larger visions that can be attained through mutually shared goals and objectives.

Our challenges require foresight and tenacity and stamina—and our cooperative science and education system has all of that. The proof of it is all around us. We have always been innovators as well as realists—we will meet the challenge of the future.

Contents

Agricultural Research
Vol. 28. No. 9
March 1980

Editor: Patricia Loudon
Assistant Editor: Michael A. Meliker
Photography Editor: Robert C. Bjork
Art Director: Deborah Shelton

Agricultural Research is published monthly by the Science and Education Administration (SEA), U.S. Department of Agriculture, Washington, D.C. 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 15, 1982. Yearly subscription rate is $10 in the United States and its territories, $12.50 elsewhere. Single copies are 90 cents domestic, $1.15 foreign. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by photo number.

Magazine inquiries should be addressed to: The Editor, SEA Information Staff, Room 3139-S, USDA, Washington, D.C. 20250. Telephone: (202) 447-6133.

Bob S. Bergland, Secretary
U.S. Department of Agriculture

Anson R. Bertrand, Director of Science and Education

Talcott W. Edminster, Administrator, Agricultural Research

Illustrations for Crops, Marketing, Plant Science, and Agrisearch Notes: p.2 Tree; p.123 Broccoli; p.211 "The Bonnet"; p.294 "Experiments in Water-culture" in *Food Gardens* by Tom Riker and Harvey Rottenberg. Copyright 1975 by Tom Riker and Harvey Rottenberg. By permission of William Morrow & Company.

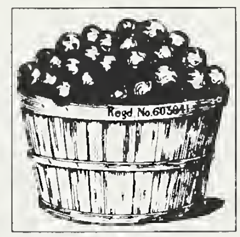
Photos on pp. 14 and 15 courtesy Grant Heilman.

Cover and opposite page: Grain storage—drying, explosions, and insect infestations are major problems for American farmers. This issue of Agricultural Research takes a look at what SEA scientists are doing to accept and conquer one of the agricultural challenges of the 1980's. Cover photo courtesy Grant Heilman; grain bins (0977B1288-31).

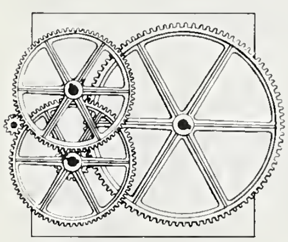
Disease

Insects

Energy



Marketing



Engineering

Plant Science

Agrisearch Notes

B. t. Controls Grain Insects

Bacillus thuringiensis (B.t.), an environmentally safe alternative to chemical insecticides, has proved effective in preventing Indian meal moth and almond moth damage in stored grain in both laboratory and field tests.

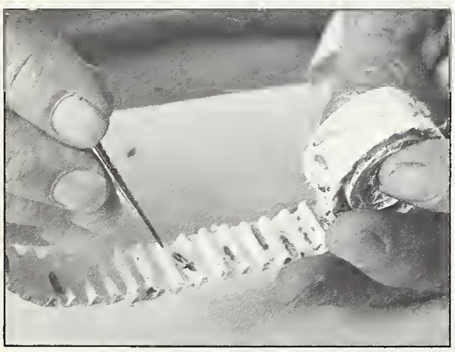
B.t. is the first micro-organism approved for use on grain in the United States. And it is the first insecticide with long-term activity or persistence approved for use on grain since malathion was introduced about 20 years ago.

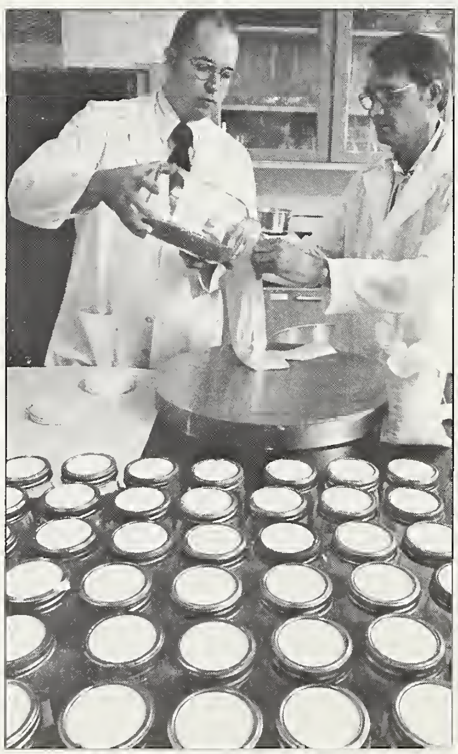
This research by SEA entomologist William H. McGaughey, Manhattan, Kans., has been applied by a company that produced B.t., and the Environmental Protection Agency (EPA) has registered it for use on stored grain.

Because B.t. is known to be pathogenic only to insects, it is exempt from tolerance restrictions. Treated grain in farm or commercial storage can be used at any time for any purpose. And B.t. is not hazardous to apply. It effectively controls moths that are resistant to malathion and synergized pyrethrins, chemical insecticides approved for moth control on grain.

B.t. is also registered for insect control in producing numerous crops as well as forest and shade trees and ornamentals. Research by SEA entomologist Carlo M. Ignoffo, Columbia, Mo., led to initial registration of B.t. as the first bacterial insecticide.

Pilot tests under simulated farm storage conditions confirmed what McGaughey observed in the laboratory (Agricultural Research, May 1976, pp. 6-7). Only a surface layer of grain about 4 inches (10 cm) deep needs to be treated with a B.t. formulation to protect a binful of grain. Larvae of the Indian meal and almond moths, unlike those of other stored-grain insects, seldom feed below the surface layer of bulk-stored grain.





Top: Research technician Edwin Dicke inspects B.t. treated bins weekly for insects (0977B1300-25).

Above: As an additional insect check, paper strips are placed on the surface of each bin for 1 week, then taken to the lab for a larvae and pupae count (0977B1298-15).

Right: In earlier research, McGaughey (left) and Dicke tested and found B.t. treatment of grain to be compatible with commonly used fumigants (0575X578-26).

Grain in the pilot tests was held in outdoor bins of about 60 bushel (20 hectoliter) capacity. The first test with corn lasted one March through November storage season; the second with wheat two seasons.

The two-season test confirmed long-term effectiveness, an advantage in time of grain surpluses.

McGaughey believes B.t. may remain toxic to moths indefinitely unless the treated grain is exposed to prolonged periods of high temperature.

Toxicity did not deteriorate in the bin studies even though the temperature at the grain surface reached 100°F. (38°C.) in midsummer during the tests. McGaughey and research assistant Robert A. Kinsinger of Kansas State University, Manhattan, earlier found that holding treated grain at a constant temperature of 108°F. (42°C.) for 42 weeks decreased insecticidal activity of B.t. by about 15 percent. Intermittent occurrence of such temperatures in grain bins was less detrimental to B.t.

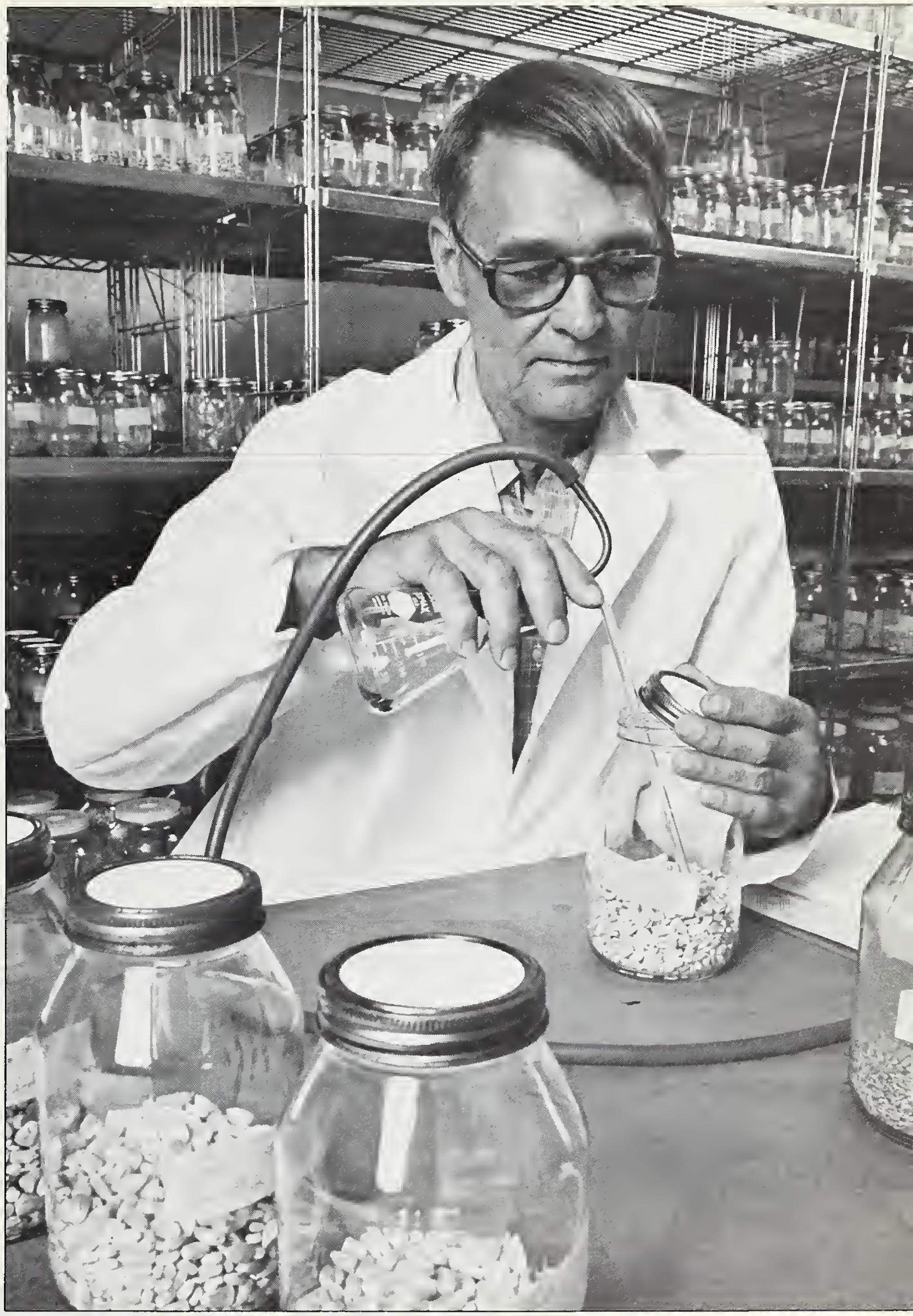
Wheat, but not corn, was already infested when it was treated. McGaughey found that moth larvae in the grain are controlled by B.t. within 2 or 3 weeks.

Surface layer treatments with 100, 125, or 150 parts per million (ppm) B.t. reduced moth populations 80 percent or more on wheat and 92 percent or more on corn. The reduction in insect feeding damage was 93 to 96 percent on wheat and 82 to 88 percent on corn.

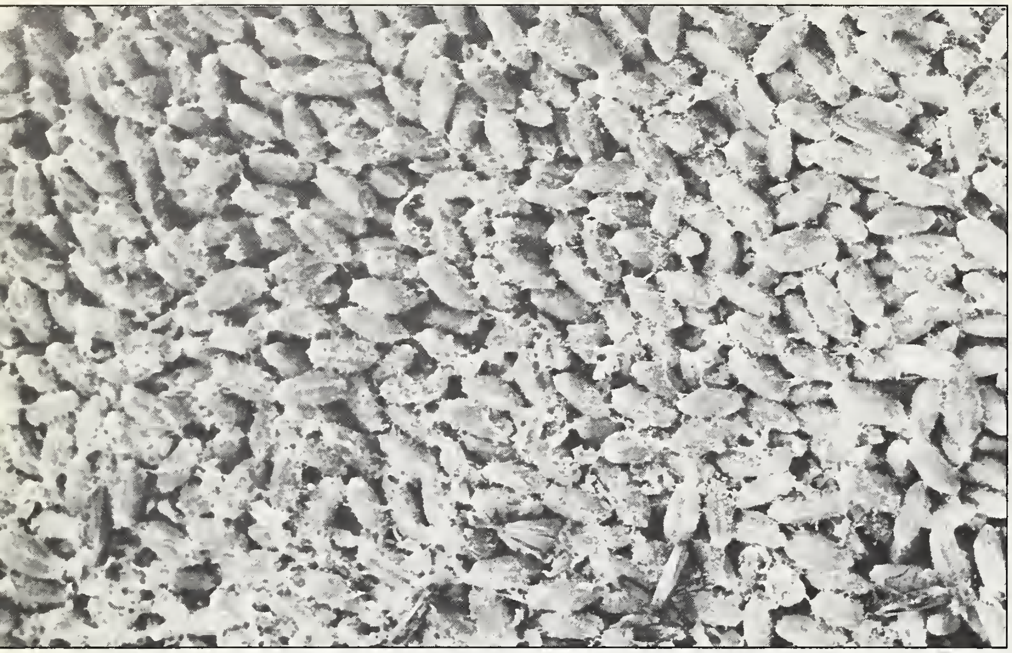
The entomologist maintained a level of infestation higher than might be expected on the farm by periodically adding 1,000 Indian meal moth eggs and 1,000 almond moth eggs to each bin.

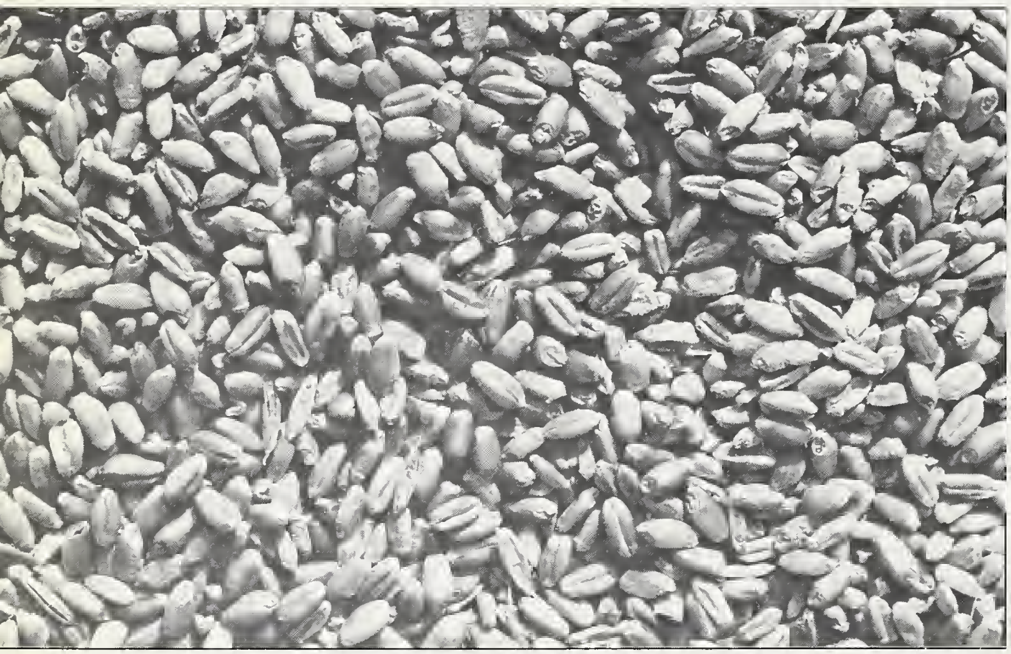
Treatment did not interfere with development of braconid wasps and mites that parasitized the few moths that developed in the bins.

Registered use is at the rate of 3/4 pound of B.t. formulation per 100 bushels of grain (equivalent to 125 ppm), or 1/5 pound per 100 square feet of grain surface. This rate gives some



Grain samples are removed from the bins at various intervals and infested with Indian meal moth eggs to determine if B.t. deposits are still toxic to the insects. Dicke counts the number of insects that survived the treatment (0977B1297-17).





B.t. effectiveness is evident when comparing untreated grain (0575X578-9) and treated grain (0977B1299-3A).

protection against variations in susceptibility to B.t. found by Kinsinger, McGaughey, and technican Edwin B. Dicke in different populations of both insect species. The insects used in the tests at the U.S. Grain Marketing Research Laboratory were intermediate in susceptibility.

B.t. treatment may restrict multiplication of the Angoumois grain moth, another Lepidopteran pest of stored grain, even though it provides little immediate control. McGaughey says brief exposure of newly emerged Angoumois grain moth larvae to B.t. on grain, before they enter the kernels for the remainder of their pre-adult life, reduced the size of the next generation by two-thirds.

Other protectants or fumigants must be used in conjunction with B.t. surface treatment for complete protection of stored grain.

McGaughey says B.t.'s effectiveness is not reduced when commonly used fumigants were also used on treated grain. B.t. does not control such Coleopteran species as the saw-toothed grain beetle, confused flour beetle, flat grain beetle, and rice weevil.

To be effective, B.t. must be incorporated fairly uniformly into the surface layer of grain. This can be done by adding B.t. to the last grain augered into the bin, or by mixing it with the surface layer of grain by hand after it is binned. The entomologist is preparing guidelines for application of B.t. under farm storage conditions.

Research methods developed by McGaughey are summarized in the stored products section of guidelines developed for use by regulatory agencies and scientists in evaluating research on microbial insecticides. McGaughey assisted in preparing the guidelines for EPA, under the auspices of the American Institute of Biological Sciences.

Dr. William H. McGaughey is located at the U.S. Grain Marketing Research Laboratory, 1515 College Ave., Manhattan, KS 66502.—(By Walter Martin, SEA, Peoria, Ill.)

Solar Grain Drying

An energy-efficient way of collecting, storing, and using solar heat for grain drying has been developed by SEA scientists. The system speeds drying time by adding solar heat to natural air forced through a binful of high-moisture grain.

Low-temperature grain drying with solar heat could be a viable alternative should cost or unavailability of energy force farmers and grain elevators to restrict use of high-temperature dryers, which have a high energy requirement.

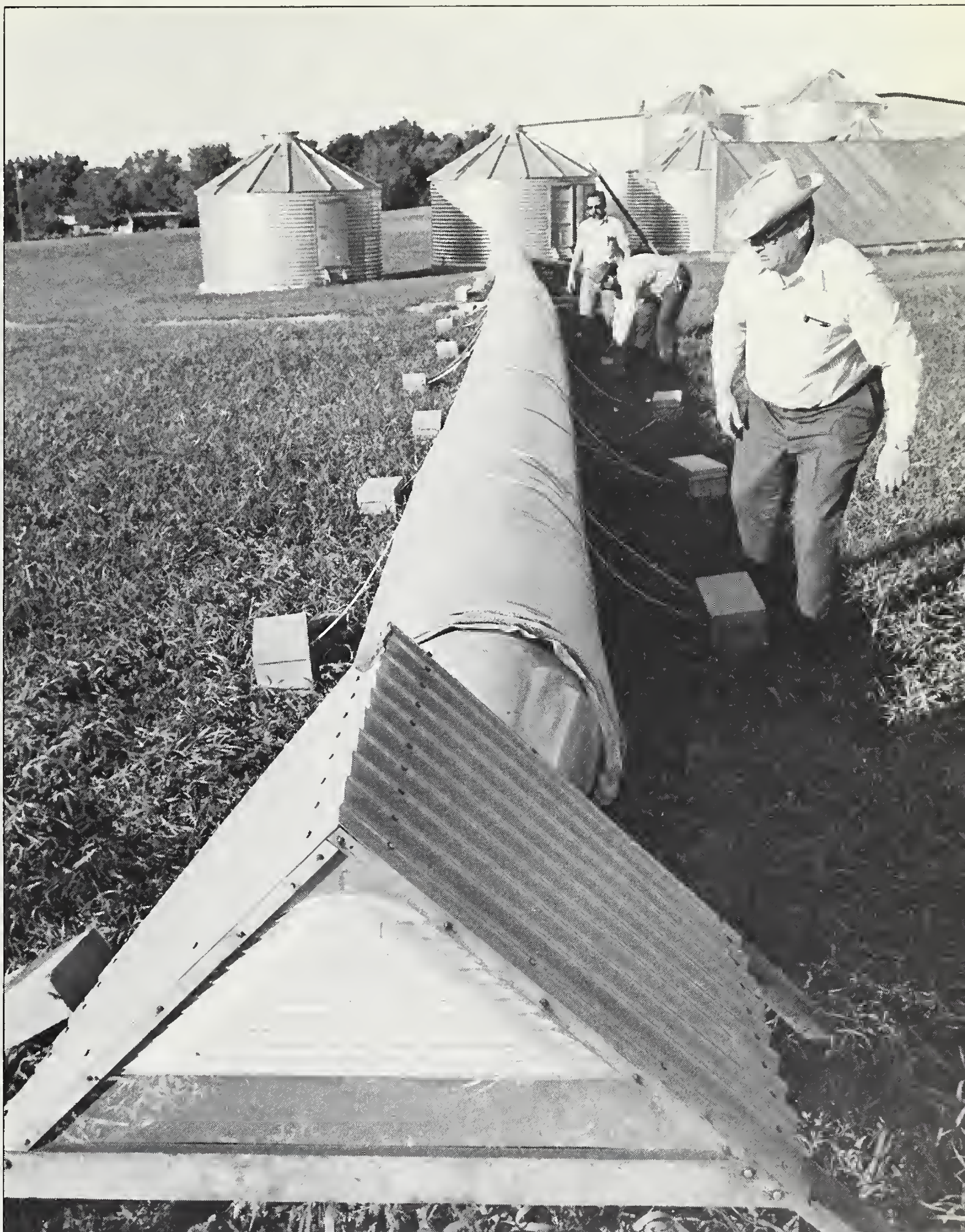
Drying time is important to producers, particularly when high-moisture grain in fields is awaiting harvest. Storing solar heat by day and releasing it to grain at night may further shorten the time necessary to reach a grain moisture level safe for storage.

Modifications were made over four seasons by SEA agricultural engineer Harry H. Converse, U.S. Grain Marketing Research Laboratory, Manhattan, who developed the system by testing a fiberglass solar collector in combination with heat storage in 32 tons of fist-size crushed limestone rock.

SEA chemical engineer Fang. S. Lai, also at the Manhattan laboratory, found that drying time was 25 to 47 percent shorter with supplemental heat from a suspended flatplate solar collector than with natural air alone. Storing solar heat in a salt solution or a desiccant (drying agent) also cut drying time, but not as much as solar-assisted drying without storage.

Finding an energy-efficient way to add solar heat is a challenge under Kansas conditions. Fall weather there usually is more favorable for low-temperature drying with natural air alone than in the eastern Corn Belt, which is more humid and has fewer sunny fall days.

The system uses a fan to force air up through grain in low-temperature drying, the engineers explain. The heat storage systems tested by Lai also used electric fans to move solar-heated air through the salt solution or desiccant (drying agent). With solar heat storage in rock, Converse operated the collector fan intermittently,



Above: This tube-type solar collector passes air from the drying fan (foreground) into the drying bin plenum, an area below the bin floor (0977B1286-35).

Left: Converse uses 32 tons of limestone rock to trap and store solar heat. A perforated duct beneath the rocks is connected to a drying fan forcing warm air into the bin (0977B1286-9).

using air temperature control and a second fan to supply air to grain.

Solar drying is more energy-efficient than natural air drying if operating time is shortened enough by faster drying to offset the fan electrical energy use during solar drying.

Converse built the combination solar collector and rock storage unit in 1975. The inclined collector cover, 12 feet wide and 28 feet long, was clear fiberglass panels. The crushed limestone covered perforated ducts connected to the drying fan and an insulated duct to the open space below the bin's perforated floor.

As originally designed, the combination collector-heat storage unit showed little advantage over an inflated collector without heat storage. Each contributed 16 percent more drying than natural air in reducing moisture of corn from 21-24 percent to 11-15 percent in early October.

Converse increased airflow for the 1977 drying tests by substituting 1-horsepower fans for ¾-horsepower fans, which also increased electrical energy use. But in the same drying time, the combination unit reduced the moisture in corn to 13.2 percent, solar heat without storage to 14 percent, and natural air to 15 percent. Corn moisture content was initially 20-24 percent, and the drying time with continuous fan operation was 15 days.

In 1978, Converse made the combination unit more energy-efficient by operating a ¾-horsepower fan at the collector-storage unit only when the exhaust air temperature from the rocks was cooler than outside air. A second ¾-horsepower fan to dry the grain operated continuously during the drying period.

The combination collector-heat storage unit was most effective, Converse found, during weather unfavorable for natural air drying.

Lai's studies compared two methods of storing heat from a suspended flatplate collector by day and releasing it to grain at night, along with solar heat without storage, and natural air drying.

The salt solution, calcium chloride hexahydrate, has a unique property of accepting or liberating stored heat when air temperature changes within a narrow range. The desiccant, silica gel, similarly transfers heat by drying during maximum solar radiation by day; then taking up moisture if relative humidity is high enough at night.

In three comparisons, Lai says solar heat without overnight storage dried grain fastest in a test begun October 10, 1978, when weather was most favorable. Corn moisture content was reduced from the initial 25 percent to 12 percent in 79 hours with solar-assisted drying, 123 hours with solar heat stored in salt solution or desiccant, and 150 hours with natural air.

Drying times for corn in a test started October 2 were 92 hours with solar heat, 113 hours with storage in desiccant, and 135 hours with storage in salt solution or natural air alone.

Weather was cooler and rainy for a drying test with sorghum begun October 16. Yet, solar-assisted drying in 141 hours was still 26 hours shorter than with heat storage in desiccant, and 46 hours shorter than with storage in salt solution or natural air drying.

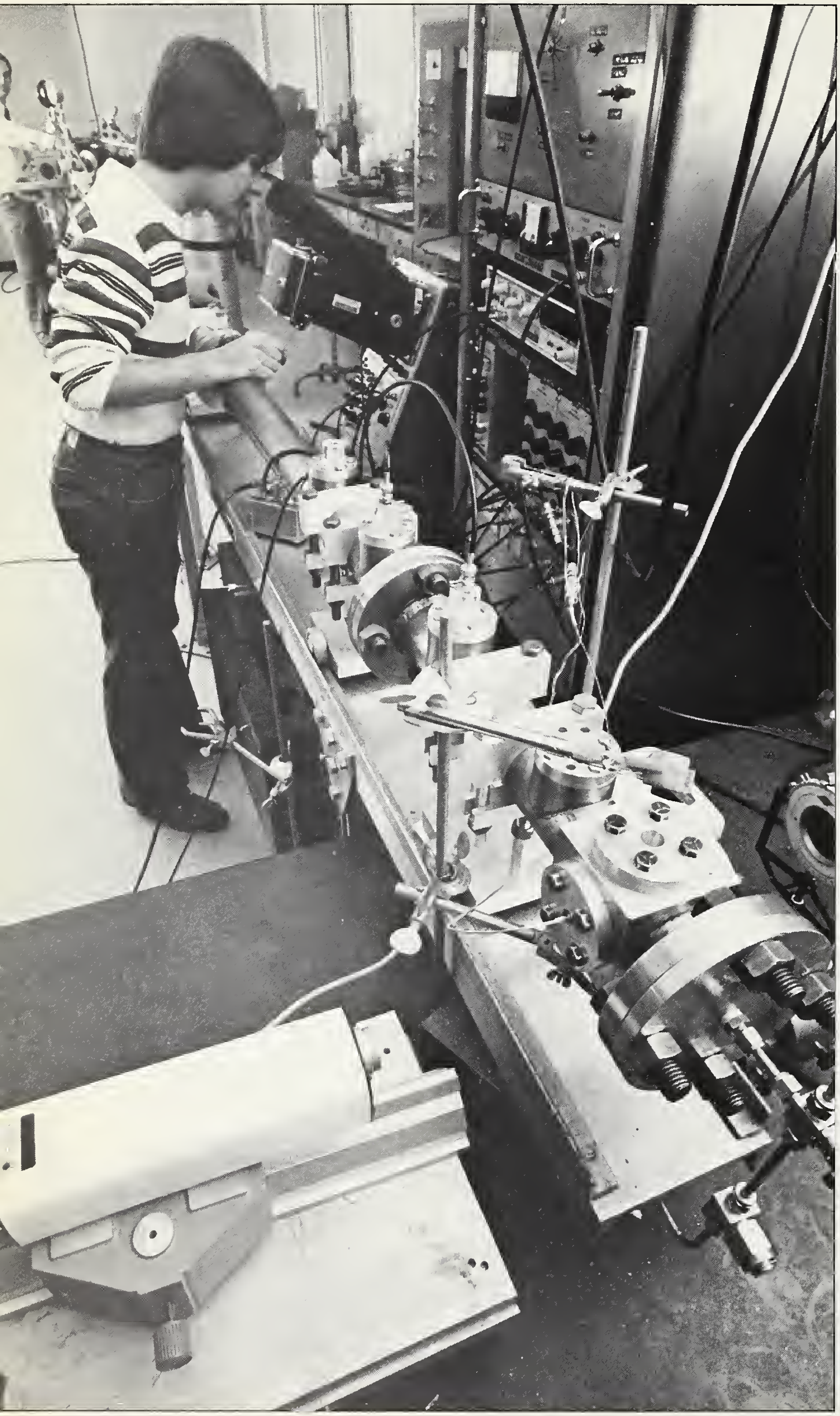
Harry H. Converse and Dr. Fang S. Lai are located at the U.S. Grain Marketing Research Laboratory, 1515 College Ave., Manhattan, KS 66502.—(By Walter Martin, SEA, Peoria, Ill.)

Above: Lai checks a hydrothermograph, which monitors temperature and relative humidity of air passing from the silica gel to drying bins (0977B1292-10).

Left: The drying fan inlet in front of engineering technician George Wyatt draws dessicated air from the silica gel unit atop the solar collector and passes it into the bin (0977B1293-21A).

Far left: Three solar collector silica gel units are used on a rotating basis—1 each night—and placed in the sunshine every day after use. Wyatt samples the silica gel for a moisture content analysis (0977B1292-7).

Grain Dust Research Progress



SEA's comprehensive research attack on the grain dust explosion problem in elevators is paying off. Engineers and scientists at the U.S. Grain Marketing Research Laboratory, Manhattan, Kans., report these preliminary results.

Reducing dust formation: Filling a bin with a commercially available grain nozzle generated only one-eighth as much dust as spout filling.

The laminar flow of grain from the nozzle carries more of the dust with the grain, SEA agricultural engineer Charles R. Martin explains. Flow from the conventional spout is turbulent, dispersing more of the dust in the air.

In another study, adding 0.04 percent soybean oil to corn or wheat before handling reduced dust formation to 6.7 percent of that in untreated grain. SEA chemical engineer Fang S. Lai and associates say the effects of treatment began to diminish in wheat stored 3 months and in corn stored 6 months.

Dust formation was also reduced to 4.4 percent immediately after treatment with 0.06 percent mineral oil, and only half as much dust was generated during handling after the grain had been stored 1 year. The researchers report no apparent effect on milling and baking quality of oil-treated wheat stored up to 12 months.

In another study, spraying water on grain before handling reduced dust in the air by 67 to 74 percent. Lai and colleagues added about 1 percent water, based on grain to volume, to corn containing 15 percent moisture. The corn was kept a year without noticeable deterioration or spoilage. Water treatment would need to be repeated each time the grain is handled.

Chemical shock waves created in this tube ignite injected grain dust—helping scientists identify causes of grain dust explosions (1178X1548-27).

Uses for grain dust: Laboratory-scale studies led by SEA agricultural engineer Cheng S. Chang indicate grain dust can be composted in 10 to 15 days to produce on organic soil conditioner or low-analysis fertilizer. Grain dust compost compared favorably with peat moss in production of tomato plants.

Wheat dust, grain sorghum dust, and a 50-50 mixture of wheat and corn dust were composted. Chang says composting corn dust alone probably is not practical because of the large amount of fine material.

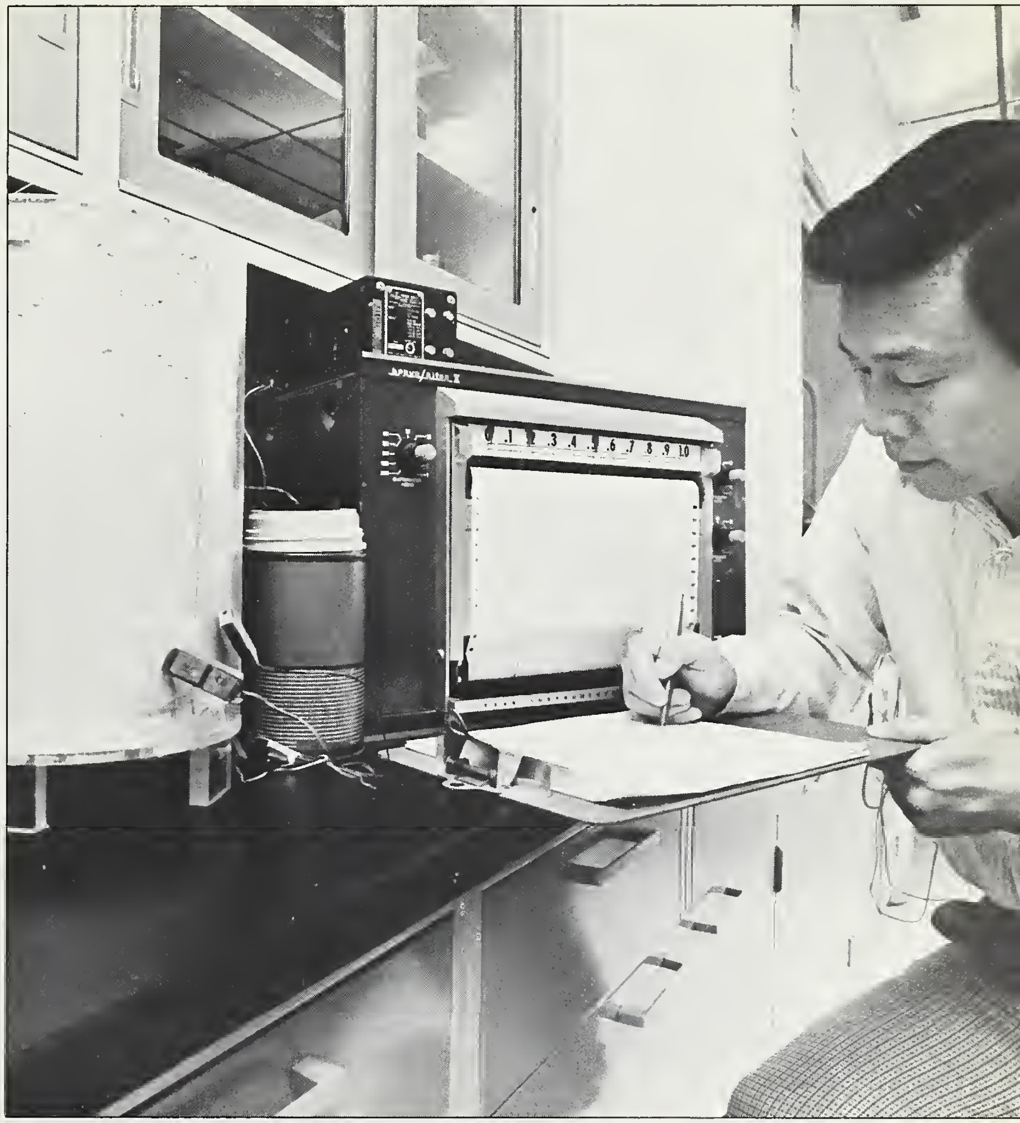
Grain dust might also be burned as a source of heat. Chang and associates recovered 10 to 16 kilowatts of usable heat per hour at temperatures of 527° to 770°F. when they burned 22 to 44 pounds of grain dust per hour in a small experimental furnace.

Chang believes the 15 to 30 percent efficiency in recovering heat from grain dust can be greatly increased by improvements in furnace design. Furnace exhaust air could not be directly used for grain drying or space heating because of its high ash content.

Stored grain insects: Insects infesting stored grain—particularly larvae feeding within kernels—are a source of dust. And SEA entomologist Hobart P. Boles and Martin found that about half of the insect-produced dust is fine starch granules and grain fragments with about the same explosibility as grain dust of the same particle size.

Failure to heed pesticide label precautions in handling grain fumigated with an 80:20 mixture of carbon disulfide and carbon tetrachloride can be hazardous, SEA entomologist Charles L. Storey warns. Labels recommend treatment at temperatures above 60°F, and that the grain not be moved for 3 to 7 days after fumigation.

Storey says handling treated grain before the two insecticides reach equilibrium may alter composition from the original formulation, creating a temporary fire or explosive hazard not normally present after waiting 3 to 7 days. And transfer of recently fumigated grain may distribute hazardous amounts of fumigant vapors throughout the grainhandling system.



Agricultural engineer C.S. Chang records data indicating thermal conductivity of grain dust, a physical characteristic essential to explosion research (1178X1545-5A).

In tests transferring grain 4 to 32 hours after fumigation, carbon disulfide concentrations in the air were above—and those of carbon tetrachloride were double—the levels established by the U.S. Department of Labor as hazardous to human health.

Dr. Hobart P. Boles, Dr. Cheng S. Chang, Dr. Fang S. Lai, Charles R. Martin, and Charles L. Storey are located at the U.S. Grain Marketing Research Laboratory, 1515 College Ave., Manhattan, KS 66502.—(By Walter Martin, SEA, Peoria, Ill.)

Cancer Breakthrough in Chickens

Researchers are now breeding chickens which they believe lack the genetic ability to produce a virus called RAV-O. RAV-O is similar to viruses which cause tumors.

This development represents a significant breakthrough, providing a base for further research into cancer biology.

"We have known for several years that chickens and other animals carry genetic information in their chromosomes to produce viruses, called endogenous retroviruses, which belong to a class of viruses that can cause cancer in animals," said Lyman B. Crittenden, animal geneticist at the SEA Regional Poultry Research Laboratory, East Lansing, Mich.

"We had thought all chickens carried such genetic material. Our discovery of birds without this genetic material appears to be a major step toward breeding chickens free of genes for these endogenous viruses," he said.

"We have flocks free from exogenous viruses (those that come from outside the animal) that have a very low rate of tumor occurrence. But we have never produced chickens that were free of genes controlling endogenous viruses (those that are carried inside the animal). This development makes the true virus-free flock seem feasible," Crittenden added.

The discovery resulted from the application of new techniques by Susan M. Astrin of the Institute for Cancer Research, Philadelphia, Pa., a collaborator of Crittenden's, and another cooperating researcher, poultry geneticist Edward G. Buss, Pennsylvania State University, University Park, Pa.

The technique determines the location of DNA on the chicken chromosome that carries genetic information for avian leukosis viruses.

"We began the studies to determine whether in fact all chickens carry endogenous viral information and if they do, whether it is at the same site on the chromosome in each chicken or inbred line," Crittenden said.

Samples were taken from 11-day-old embroys, cultured cells, and whole blood from adults. Then DNA materials were prepared by digesting, that is, by cutting the DNA into fragments with enzymes. Specific enzymes cut the DNA at specific, predictable sites. The fragments were then separated by gel electrophoresis, and hybridized with virus RNA. This test tells the researcher whether or not the DNA fragment contains the genetic information for endogenous virus, and the size of the DNA fragment, if it does occur.

During the evaluation of samples, the researchers were somewhat surprised to find one embryo without the genetic DNA material for production of RAV-O.

"One male from the same mating was found to be free of these genes and has produced progeny. When offspring of this rooster are large enough for samples to be taken, their genetic material will be checked for genes carrying endogenous virus, and we will attempt to develop an endogenous virus-free strain," Crittenden said.

This collaborative research demonstrates for the first time that chickens without endogenous viral information can survive and function normally.

Dr. Lyman B. Crittenden's address is the SEA Regional Poultry Research Laboratory, 3606 E. Mt. Hope Road, East Lansing, MI 48823.—(By Ray Pierce, SEA, Peoria, Ill.)

Powdery Mildew Cuts Soybean Yields

Powdery mildew caused yield losses as high as 26 percent in susceptible soybean varieties in a 3-year study at three Iowa locations. Average yield losses were 7.7 bushels per acre for the Corsoy variety, 6.5 bushels for Harsoy, and 4.7 bushels for Kanrich.

"We are not sure how the fungus actually causes yield losses. It may be a reduction in light reaching the leaf because of heavy fungus growth on the leaf's upper surface which makes the disease so conspicuous in the field. Reduction of light on leaf surfaces reduces photosynthesis, which provides nutrients for plant growth," says John M. Dunleavy, SEA plant pathologist at Ames, Iowa.

Dunleavy ran the tests from 1976 thru 1978 at Kanawha in northcentral Iowa, Nashua in northeastern, and Ames in central Iowa. Natural infection was provided by planting a susceptible variety adjacent to the test plots. He controlled powdery mildew on some plots by spraying weekly with benomyl, a fungicide, and comparing yields from the sprayed and unsprayed plots.

Caused by the fungus *Microsphaera diffusa*, powdery mildew has been common in the southern United States for many years, but was rarely seen in Iowa until 1973. It has also been seen recently in Illinois and Minnesota.

In earlier years, varieties commonly grown in Iowa were resistant to powdery mildew. They included such varieties as Adams, Beeson, Blackhawk, Calland, Chippewa, Clark 63, Ford, Lincoln, Lindarin 63, Shelby, and Wayne.

In the absence of powdery mildew, susceptible varieties Harosoy and Harosoy 63 replaced lower yielding ones and were used in breeding. They were probably the source of susceptibility in such presently grown varieties as Amsoy, Amsoy 71, Bonus, Corsoy, Harcor, and Wells, Dunleavy says.

Dr. John M. Dunleavy is located at the Department of Botany and Plant Pathology, Iowa State University, Ames, IA 50011.—(By Ray Pierce, SEA, Peoria, Ill.)

Vaporizing Powdery Mildew

Powdery mildew, the number one problem for greenhouse rose growers, can be completely controlled using a SEA-developed treatment that is inexpensive and requires little labor.

The key to the new treatment is heating a selected fungicide enough to volatilize it. The vaporized fungicide is then left unattended overnight in a greenhouse to eliminate powdery mildew without harming the roses.

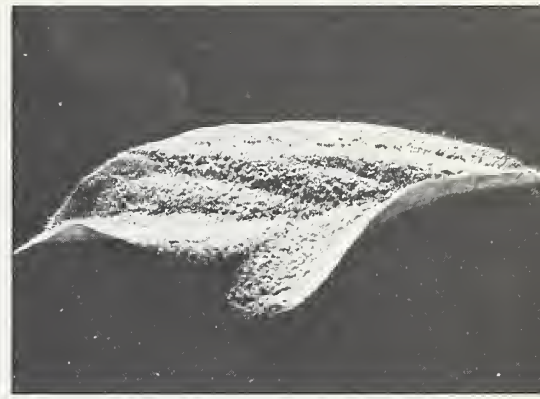
Powdery mildew cripples greenhouse rose production, annually costing growers millions of dollars in losses. The fungus gets its name from powdery white blotches which appear on the leaves of infected plants.

At present, fungicides used to control powdery mildew are applied in the greenhouse by spraying—a slow procedure requiring special skills to achieve adequate protection. Residue left by certain fungicides may damage some rose foliage. During a powdery mildew epidemic, roses should be treated every 3 to 5 days in order to break and control the disease's life cycle.

Duane L. Coyier, a SEA plant pathologist at Corvallis, Oregon, found that by fumigating a greenhouse with a volatilized fungicide, only a tiny fraction of residue is deposited on foliage, but enough fungicide reaches the leaf surface to kill powdery mildew.

In testing his treatment, Coyier uses experimental and commercial fungicides that are commonly applied in greenhouses against powdery mildew. Most of these fungicides are in liquid spray form and have low volatility. Coyier uses the same spray treatment quantities but increases the volatility of these fungicides by heating them for 5 to 8 hours at 150 degrees C. (302 degrees F.).

Venting a greenhouse following fumigation allows growers to reenter the building immediately after a treatment. Reduced residue on the foliage lessens greenhouse workers' exposure to the fungicide. Combined with this treatment's safety to plants, growers can repeat it often enough to prevent powdery mildew from ever getting established in a greenhouse.



An unprotected leaf covered with powdery mildew (PN-6800) and a leaf fumigated with a volatized fungicide (PN-6801) show the effects of treatment.

Whether it is because of powdery mildew elimination or stimulation of growth by the fungicides, Coyier's treatment has resulted in a doubling and soon maybe even a tripling of rose production in his test greenhouses. He believes it can be used on other greenhouse grown plants susceptible to powdery mildew and has successfully tried the treatment on wheat, mint, peaches, apples, and begonias.

Dr. Duane L. Coyier is located at the SEA Ornamental Plants Research Laboratory, 3420 Southwest Orchard Street, Corvallis, OR 97330.—(By Lynn Yarris, SEA, Oakland, Calif.)

Bees Increase Melon Size

Bee hives in cantaloupe fields increased both the number and size of melons in research near the Fruit and Vegetable Insects Research Laboratory, Vincennes, Ind.

SEA research technician Thomas E. Mouzin placed four hives per acre, each containing 30,000 or more bees, on four different farms in the Vincennes area in 1977.

He counted the number of bees and counted, measured, and weighed melons from randomly-selected 40-inch square areas harvested during the growing season. He found that mature fruit near the hives weighed an average 4.9 pounds. Melons from acres 200 yards or more from the hives averaged 4.5 pounds each. The 0.4 pounds-per-melon weight difference becomes significant when multiplied by the thousands of melons harvested per acre, Mouzin says.

"Not only were the melons 8.8 percent heavier," he said, "but the plants close to the hives produced 23 percent more melons than those away from the hives."

Mouzin believes hybrid vigor may be the reason for size differences as a result of more cross pollination of plants closest to the hives. Increased numbers of melons, of course, are attributable to increased pollination.

Mouzin repeated the tests in 1978, reducing the number of hives to one or two per acre, and found similar results. Melons near the hives averaged 4.4 pounds, while those 200 or more yards away averaged 4.1 pound each.

David K. Reed, research and location leader, says the figures indicate that one hive per acre provides enough bees, but we need more tests to make a more accurate recommendation.

"Melon growers in the area have been bringing in hives at a high rate since we started the project in 1977," Reed says. "In fact, we had a difficult time finding areas without hives for our tests this year."

Thomas E. Mouzin and Dr. David K. Reed are located at the SEA Fruit and Vegetable Insects Research Laboratory, 1118 Chestnut St., Vincennes, IN 47590.—(By Ray Pierce, SEA, Peoria, Ill.)

Cantaloupes vs. Nematodes

Nematodes attack the roots of plants and severely reduce market quality and yield. Although growers are generally aware of the damage these tiny roundworms cause, they may not realize the extensive loss in quality and yield.

A study of the effect of the reniform nematode, *Rotylenchulus reniformis*, on the quality and yield of cantaloupe, reveals that marketable yields are increased as much as 50 to 100 percent when soil fumigation is practiced.

In tests conducted between 1975 and 1977 on 'Perlita' cantaloupes, *Cucumis melo*, SEA nematologist Charles M. Heald compared the effects of fumigation in sandy loam plots in the Lower Rio Grande Valley of Texas. The plots were in a field naturally infected with reniform nematodes.

All fumigation was applied to a depth of 25 cm. In 1975 and 1976, researchers used Telone II (1,2-dichloropropene) at the rate of 46.7 parts per hectare. DBCP (1,2-dibromo-3-chloropropane) was used in 1977 at the rate of 9.3 parts per hectare. Nonfumigated check plots served as controls.

Soil samples around cantaloupe roots revealed that fumigation significantly reduced reniform nematode populations. In 1975, fumigated rows of cantaloupe showed an increase in total melon yields of 105 percent. In 1976 and 1977, fumigated rows produced 82 and 79 percent more marketable melons, respectively, than nonfumigated rows. Nematode control also increased melon sugar content.

Dr. Charles M. Heald is located at the SEA Subtropical Fruit and Vegetable Research Laboratory, P.O. Box 267, Weslaco, TX 78596.—(By Eriks Likums, SEA, New Orleans, La.)

Chemical Decay Control

Shipping cantaloupes in rail cars, trailers, or other containers, in which the air includes higher than normal amounts of carbon dioxide (CO_2), holds promise as a means of reducing fruit decay.

Cantaloupes are susceptible to stem scar mold, surface mold, and flesh decay when shipped in "normal" air.

"Essentially, all melons shipped either within the United States or to foreign countries are treated with chemicals to inhibit mold growth and decay. However, resistance of the public to chemical use for decay control is increasing. Some countries will not accept produce containing what they consider to be excessive chemical residues," says SEA horticulturist Joseph K. Stewart of Fresno, Calif.

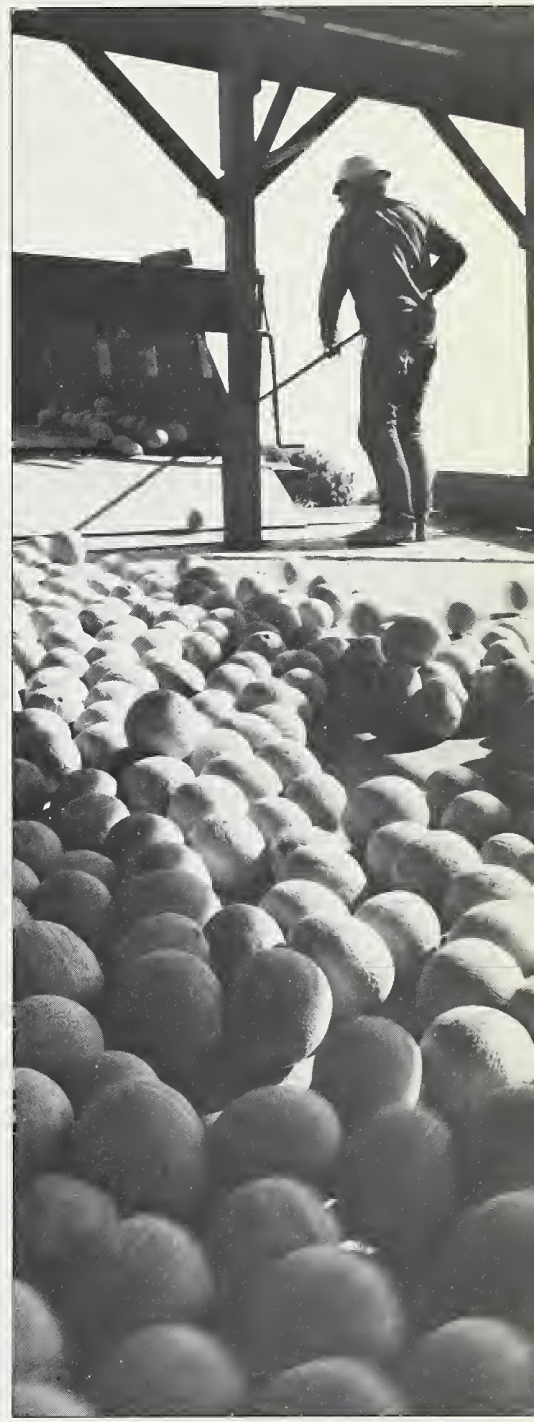
Stewart found that cantaloupes stored at temperatures of 5°C (41°F) for 14 days in a modified atmosphere containing 20 percent CO_2 and 21 percent oxygen—the rest nitrogen—had less mold than melons held in other atmospheres. He found this treatment compared favorably with present chemical treatments. And CO_2 leaves no toxic residue.

Stewart used the same time and temperature in the study as that required to export produce from the United States to European or Far East markets. Much research has been conducted to determine the effects of modified atmospheres on many fruits and vegetables, but little on cantaloupes until now.

Relatively few commodities can tolerate CO_2 levels of 20 percent without injury but cantaloupes can.

Modifications to existing equipment will probably be necessary in many instances, but rolling stock such as truck trailers and containers for marine transport can be modified to maintain high CO_2 concentrations, Stewart says.

On-the-farm value of cantaloupes in the U.S. is about $108 million from 73,000 acres. They are grown in Arizona, California, Colorado, Georgia, Indiana, Michigan, Ohio, South Carolina, and Texas. California leads the Nation in melon production with nearly a third of the total.



Dr. Joseph K. Stewart is located at the SEA Horticultural Field Station, 2021 S. Peach Avenue (P.O. Box 8143) Fresno, CA 93727.—(By Paul Dean, SEA, Oakland, Calif.)

U.S. Government Printing Office
Public Documents Department
Washington, D.C. 20402
Official Business

Postage and Fees Paid
U.S. Department
of Agriculture

AGR-101

U.S.MAIL

Agrisearch Notes

Harvesting Grass Seed. Results of a 3-year test on orchardgrass, conducted by SEA agronomist John G. Dean, Cheyenne, Wyo., show that harvesting grass seed before 80 percent of the heads are ripe causes genetic shifts or changes toward early maturity.

For example, when only 40 percent of heads are ripe, harvesting collects a greater proportion of seeds that have traits for early maturity and fewer for intermediate or late maturity. And earlier harvesting collects fewer seeds and some that aren't mature enough to sprout when seeded.

The best harvesting time, at 80 percent maturity, results in maximum seed yield for seed producers and gives growers the longer season varieties they need. Grasses that mature throughout the growing season provide a longer grazing period for livestock as compared to early maturing varieties.

The same orchardgrass variety can show different maturity traits in different parts of the country. In the northern states, all types in a variety may mature in 2 or 3 weeks, while in other parts of the country it would take 6 to 8 weeks. Careful harvest scheduling can help extend the seed production area of a given variety southward and still maintain its maturity traits.

Dr. John G. Dean conducted his research while stationed in southern California. His current address is USDA High Plains Grasslands Research Station, Rt. 1, Box 698, Cheyenne, WY 82001.—(By Dennis Senft, SEA, Oakland, Calif.)

Spent Grain. Leftovers may be the best part of grain used by brewers. After barley is used to make malt for beer production it is actually "enriched", because only the starch has been removed, leaving concentrated protein and fiber levels.

SEA researchers tested brewers' spent grain as a protein and fiber supplement in baked products. The combination of a large supply (about a million tons of dried spent grain are produced annually in the United States), low cost, and high nutritional value makes spent grain a good potential source of human food.

Spent grain was substituted for 10 to 40 percent of cookie flour. The 20 percent level produced acceptable sugar-snap cookies containing 55 percent more protein, 90 percent more lysine, and 220 percent more dietary fiber than cookies made from soft wheat flour.

Leo T. Kissell (retired) conducted the research at USDA's Soft Wheat Quality Laboratory, Ohio Agricultural Research and Development Center, Wooster, OH 44691. — (By Ray Pierce, SEA, Peoria, Ill.)

A Common Foe. Apple and cherry growers face a common foe. A serious apple disease and a major cherry disease have been identified as one and the same. Remedial actions previously recommended would result in continued disease problems for growers of both fruits.

SEA plant pathologist Curtis Lee Parish, Wenatchee, Wash., has established that flat apple and cherry rasp leaf are actually a single disease with two different names. The host range of the two is identical. If apple trees are planted where rasp leaf-infected cherry trees have been, the apple orchard will most likely contract flat apple. The reverse holds true for cherry trees planted where a flat apple-infected orchard has been.

Flat apple drastically reduces useable apple yield. The disease spreads slowly through the tree, causing the fruit to become flat and deformed. Rasp leaf causes cherry trees to decline until they are economically worthless.

The disease situation for both fruits is pretty much under control today because of nursery certification and other disease prevention programs. However, Parish warns that the disease still occurs and poses enormous problems. In the 1950's, the cherry industry almost collapsed because of a rasp leaf outbreak.

"The only safe thing to plant is pears," says Parish. "The disease doesn't affect pears. Infected apple or cherry orchards could be treated with methyl bromide and a nematicide (the disease is carried by nematodes in the soil), but this is very expensive and not always effective."

Dr. Curtis Lee Parish is located at the SEA Fruit Research Laboratory, 1104 North Western Ave., Wenatchee, WA 98801.—(By Lynn Yarris, SEA, Oakland, Calif.)